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THE RESEARCH AND STOPING OF A PYRITE BODY, CONCENTRATION AND UTILISATION OF THE EXTRACTED ORE

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THE RESEARCH AND STOPING OF A PYRITE BODY : CONCENTRATION AND UTILIZATION OF THE EXTRACTED ORE

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1. Preliminary Remarks

a) The subject we are dealing with is rather general and it does not contain anything new, therefore it should not represent a particular contribution to the purpose of the meeting without pointing out what follows.

b) Amont the characteristics of the underdeveloped countries are the abundance of low cost unskilled labour, the lack of technicians and skilled labour, of primary sources of energy and of easy communications, the absence of the essential infrastructures.

c) As a consequence, we see the tendency of industry to start in the same way as all the industries once started and to repeat the same process of development they had in a world where competition is not the old one and where a wrong start can mean the end of the industry or the survival in the underdeveloped country of the same social and economic back conditions.

d) In Italy, the pyrite industry, as a consequence of the strong competition existing in the sulphur market is an obvious example; recently one of the main Italian producers felt the necessity to transform radically the methods of the concentration and utilization of the mineral mined from the largest Italian pyrite field reorganizing, in the meanwhile, the structures of the mines.

e) Therefore, when laying out a mining industry in a regime of competition like the pyrite one, the infrastructures of the mine and those of the utilization of the mineral, must be based on the most advanced concepts of the modern technique. The abundance and the low cost of labour must not induce us to repeat the historial process of development; even if at the beginning it is possible or necessary to substitute the use of very expensive equipment by employing hands at low cost, the laying down of the research and mining programme must consider the future use of the above equipment in such a way that a possible and preferable technical development should not cause difficulties, but be a natural and gradual transformation.

2. Exploration and research

a) The utilization of the most up-to-date methods to obtain an exact evaluation of the mine body and the knowledge of its genesis are considered to be of essential importance. There are examples showing that the initial incomplete knowledge of a body has been the cause of an incorrect mine research programme and organization of extraction infrastructures, haulage and stoping. A mine even though of small size or attractive because of favourable outcrops, must not be started unless the geology and the mineralogy of the zone has been studied in advance. This procedure implies the use of a special geological team charged to ascertain the zones requiries the help of photogelogical and geophysical prospecting as the introduction to the mechanical research (by drilling).

b) The object of the geological prospecting, besides the interpretation of the mineralization genesis, must be the identification of the main structures, the soil where the mineralization took place, the identification of the hydrostatic level and permeability of the rocks, the existence of water bearing levels of a different nature. Among the various geophysical methods that can be used, if the results are very cautiously interpreted, is the spontaneous electric polarization method, the resistivity methods and so on for the investigation on ore concentration, and seismics or gravimetrics methods for the interpretation of the large structures.

c) The above operations should be completed by direct exploration through mechanical boring carried out in conformity with a scheduled plan which has to be entirely and in the shortest time fulfilled in order to reduce the capital cost, in accordance with the correlation requirements of drillings to locate the following ones.

This work too must be carried out by firms very skilful in drilling operations.

d) The results obtained should lead to the geologist and to the mining engineer indentifying the mineralization process and its dimensions regarding planimetry and depth. The use of stereographic representation of the mine body, realized by assembling sections on vertical or horizontal planes made of transparent materiel will be made easy by tridimensional vision of the same and the mining technician will be enabled to lay down in a more rational way the first tracks of access to the mine body and the main ways for the extraction, ventilation and education.

e) There are still many Italian pyrite mines, which started their activity without having a complete knowledge of the body and developed from the first outcrops, using a large number of workers and a mining equipment strictly proportional to the requirements of that time. These mines are now heavy burden because they are unable to meet higher output demands and are inadequate in depth and for any extensive developments of the mineralization.

f) Therefore a perfect knowledge of the mine body is required in order to fix the structure of the mine in such a way as is required by the consistence of the mineralization.

Access to the mine body, mining works for the stoping

a) If, by the above mining study, it has been possible to identify the mine body, and the preliminary planning of the whole frame concerning the future mine, can be decided the time required for the various works fixed, and the priority given to those regarding access to the direct identification of the mineralization. These works must be carried out according to a plan considering future and not only present requirements. In this way every mining work is of immediate usefulness as per planned priorities and at the same time is a part of the mine projected to meet future requirements. This is valid for all the installations, externals included.

b) The starting of the operations can be performed by using self-contained temporary equipment (motor generator units, mobile motor compressors and so on). If it is possible to construct two access ways to the mine (shafts, manways or through seams at various levels) and two galleries forming the extraction unit, air inlet and the flow back and services unit; the temporary equipment should be preferably installed in the zone of the services so that their use may be prolonged and be useful, besides the identification and the layout of the most important part of the underground system, during the following stage and at the beginning of this particularly.

   In the meantime the final erection of the extraction structures and of the installations which consequently should not be disturbed, during the prospecting and development stage, should be carried on.

c) The size of the shafts and their galleries must consider the full mine development as per the preliminary planning even if the body is initially exploited in its nearest and more approachable parts.

   This planning must duly consider mechanization requirements, either in fixing the section and the layout of the galleries in order to permit the passage of heavy locomotives and the installation of belt conveyers, or in the timbering, to put them in a position to support the high speeds and heavy loads of a skip required for up-to-date extraction.

   From the very beginning, therefore, the use of wagons having a large carrying capacity should be advantageous as they would always make possible eventual increasing of production and realize the best stopes and transport efficiency even if these operations would have to be at first carried out by hand.

d) The final external installations (transformation cabin, compression station, workshops and stores) must adapt to easy enlargement for setting up other installations of the same kind and, this choice, therefore, must consider this eventuality and its convenience.

   The excavation and loading equipment should be chosen after investigation on the industrial market giving the preference to those requiring a reduced maintenance and having up-to-date technical features.

e) The experience of the work carried out in the Italian pyrite mines suggests the use of hammer drills air leg mounted dulls weighing from kg. 21 to kg. 25, mechanical cutters with operating capacity of 50/60 tons per hour and scraper from 30 to 50 HP. These simple machines are by now of general use and they permit the employment of semi-skilled labour and are useful in carrying out works of secondary importance in time of high mechanisation too.

4. Stoping methods

a) The particular research performed through the preliminary mining works, should have completed determinations concerning the static characteristics of the mine body, the hardness and compactness of the ore for mining purposes, the collapsing degree of the rocks. The type and the trend of the mineralization should also have been determined. On the basis of the above knowledge must be chosenthe stoping method which has been already outlined when projecting the main structures.

b) It is possible to classify suitable methods in conformity with the type of mine body. These methods may change if the mine body is of lenticular or bedded type having its main dimensions in two directions, or if the type is the so called "shoot" having three directions of equivalent dimensions or in accordance with its inclination.

c) The examination of the above mentioned conditions should make it possible to know if the method to adopt is with gob or not.

This decision must be carefully taken because it implies a different organization of the whole mine; if there are doubts on the use of the gob method, a new organization scheduling it is essential, so that any eventual change should be made under more favourable conditions.

d) Among stoping methods employing a large number of hands without being obliged to make use of special mechanical equipment we mention the rising reverse bench carried out by gradual and continuous excavations or serially the store chamber first and its filling next. The waste filling is located in the dump and can be carried out with hand tilted wagons; its transformation into a mechanical unit can be made without altering the stoping method, using a dumper or a scraper. The stopes have generally large dimensions and are suitable to the introduction of machines.

When the pyrite extracted in stopes using the reverse bench or store chamber method is of normal compactness we can obtain, gob included, a yield of 8/10 tons per man and there is a chance of raising it, after having mechanized the loading of the ore and the unloading of the gob, to 20/25 tons per man. To use these methods a compacted ore and a rather hard back is essential.

e) Where it is possible to work avoiding the waste filling method, and the back is rather solid, and the stopings in a position the use the scraper to carry on the stoping and the mining, obtain

the best results. We may classify among these methods, that concerning retiring underlevels suitable to the case of a sub-vertical stratified body or that concerning parallel slants the central as a scrapering unit and the lateral ones as drilling and anchorage for pulley transmissions units. This last method, first used in the S. Giovanni Rotondo's bauxite mines has been applied in the pyrites of Niccioleta and the Isle of Elba. The yield vary from 12 tons per man during the development to 25/28 tons per man during the stoping stage. The mechanical installations are reduced to a few scrapers, 3 calf wheels of 50/80 HP and pneumatic drills. This method is more suitable in case of regular strata having a slight inclination and less than 6/8 metres thickness. These above mentioned methods require a limited equipment and they give a height rate of production, therefore they should be always used even in the case of the productive transformation of the mine.

f) A particular consideration is due to the case of the shoot mine bodies formed by friable ore and an example is given by a big Tuscan mine. A rising stoping is not possible because of the liability of the ore to fall in; therefore the whole removal and the replacement of the body is carried out by using the gob and slope stoping by the near-side cuts method. Considering that the difficulty in settling the gob by hand and the slowness in carrying on this operation would require a productivity reduction of the yards the use of the pneumatic system is advisable to settle the matter and to obtain a sufficient degree of solidity in order to permit the passage of the successive stopings under the gob. The above operations require considerable external compression installations as well as an internal system of regular distribution of the gob to the machines. To make up for it, high filling potentialities per hour may be achieved so that remarkable yard productions are obtained. Therefore, in the case above described, even if the starting of the stoping may be carried out using the hand gob method, the structure of the mine must secure an easy arrival of the material from the exterior and an easy distribution along the gangway to make possible the future mechanization of the gob.

5. Dressing and transportation means

a) The mined pyrite must be removed and conveyed to the industrial utilization. After having considered the distance from the mine to the utilization places and the road conditions, a decision concerning the advisability of a preliminary concentration in accordance with the content of the mined ore has to be taken. Normally the concentrations of nearly pure ore are frequent in pyrite mine bodies and it is a rule to separate the extraction of the rich pyrite from that intermixed with waste; rich pyrite is that having a commercial content (more than 47 % of sulphur). Therefore the concentration problem concerns only a part of the whole production, but the crushing of the whole production under 12 mm., is required.

b) The dressing is generally carried out by crushing, classification and washing by hydrogravimetric machines, largely using Symons type conical crushers, vibrating screens and sieves. The vanners once used for the best ore have been everywhere replaced by flotation equipment for the tailings which can recover the rich sediments coming from the crushing by the wet method. Hydrocyclones and Dorr thickeners are often used for thickening.

c) The operating and maintenance cost of this dressing is about $ 0.20/0.25 per ton of crushed ore, $ 0.50/0.75 per ton of washed ore, $ 1.20/1.40 per ton of ore already passed in flotation. By these installations a commercial production having 48/49 % of sulphur may be achieved.

The installation cost for crushing equipment is about $ 150 per ton of ore dressed per 16 hours, washing machines about $ 500 per ton of ore washed per 16 hours, flotation equipment $ 1,400/1,500 per ton dressed per 24 hours.

d) For workshop services, water supply, electric energy required by the above installations, the first thing to examine is the possibility of centralizing the ore dressing which may be carried out, if there are some mines not far off, either in one of these or in the ore utilization site if the starting of a utilizing industry takes place in the same producing Country, In this connection must be pointed out that pyrites, until now considered as a sulphur ore, is going to lose more and more its importance in the world market because of the costantly increasing production of regenerated sulphur in addition to the natural production at low cost of this metalloid.

e) Consequently we shall have to increase the pyrite utilization as iron ore, and as a consequence of this change the concentration methods until now used (above described and planned to obtain a sufficient sulphur content in order to reduce ore transport cost) are no longer in a position to obtain a better iron or utilization.

f) Following this different trend, in Tuscany, in the largest extractive pyrite body, has been erected a big centralized installation for the utilization of the pyrite as soon as extracted, without concentration process, to obtain sulphur acid and electric power, as by products of iron pellets at 66 % Fe; so that in this way, high contents are obtained through a utilization process directly carried out on ashes coming from pyrite furnaces. It is advisable to bear in mind these new trends which practically are imposed by the situation of the sulphur market.

Conclusions

a) The subject dealt with is too wide to be entirely developed by this short note.
We wanted to draw attention to the necessity, when facing the various problems concerning the research and the stoping of a pyrite body, even if there are favourable conditions for the large use of labour, to foresee an eventual mechanization and to plan the mine in the same way as if its starting had taken place in a developed country.

b) Besides we reported on the new trends concerning the concentration and the utilization of pyrites as they are of main importance in planning a new industry in a country not engaged with traditional markets.

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